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ABSTRACT

The Purdue Interest Questionnaire (PIQ), a 264-item Likert-type scale, was developed to assist engineering students in their career planning. The six engineering scales identify specialized fields: aeronautical, chemical, civil, electrical, industrial, or mechanical. For students planning to transfer out of engineering, four scales identify interest in other fields: humanities and social science, industrial management, science and mathematics, and engineering technology. Two scales measure general educational orientation--for students most likely to persist in engineering, to transfer, or to withdraw from college. The scales were developed in 1966 by analyzing existing interest inventories, and by comparing the responses of 99 freshman engineering students with selected groups of other freshman engineering students. The PIQ has some limitations--it is not an ability or achievement measure, and few women participated in its development. Scores are compared both against scores of freshman engineers in general, and against ten mutually exclusive groups--those persisting and those transferring from the field. Although test-retest reliability coefficients of some scales are low, they are all significant. Discriminant function classification of students, based upon their PIQ scale scores, produces significant percentages of correct classification beyond chance--thus demonstrating PIQ validity. (CP)

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THE PURDUE INTEREST QUESTIONNAIRE - AN INTEREST INVENTORY TO ASSIST ENGINEERING STUDENTS IN THEIR CAREER PLANNING

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Abstract

The retention and attrition of engineering students has long been of major concern to the Department of Freshman Engineering at Purdue University. Cognitive measures have been found to be the best predictors of engineering retention and attrition. However, interests have also been found to be related to retention and especially relevant to the specialization fields in which engineering students graduate or to which they transfer. In an effort to help counselors and students identify potential engineering fields or transfer fields, the Purdue Interest Questionnaire (PIQ) was developed. Specifically, the PIQ was developed to help students select specialization fields within engineering if they plan to remain in engineering or non-engineering fields if they plan to transfer.

A PIQ profile of scores and comparative norms are presented along with mean scores for various engineering and non-engineering fields on the thirteen PIQ scales: six Engineering Scales, four Transfer Scales, and two General Scales. Reliability and validity data are also presented. In summary, although some test-retest reliability coefficients of some scales are low, they are all significant ($p < .001$). Similar data are presented demonstrating validity of the PIQ scales. Also, discriminant function classification of students based upon their PIQ scale scores produces significant ($p < .001$) percentages of correct classification beyond chance. It was found that these percentages of correct classifications could be greatly enhanced if both first- and second-choice classifications are considered. It is concluded that the PIQ scales can be of considerable assistance to students and counselors in educational/career planning and decision making, especially when used in conjunction with cognitive data, such as aptitude and academic achievement information.

Introduction

For over two decades, almost from its inception in 1953, the Department of Freshman Engineering at Purdue University has been conducting research on the factors associated with retention and attrition of engineering students in engineering. We have conducted literally hundreds of studies attempting to develop cognitive and affective measures that would either predict in advance or explain in hindsight the factors associated with the retention of students in engineering, the transfer of students to non-engineering fields, and the withdrawal of students from college altogether. National studies have also focused on these factors.[1]

These studies have indicated that cognitive measures, such as high school rank, high school grades (especially in mathematics and science), aptitude and achievement tests (especially in mathematics), and college grades (e.g. freshman grades in mathematics, chemistry, and physics), are the best predictors of engineering retention or attrition.[2] Affective measures--such as study habits, interest tests, and personality tests--and demographic, socio-economic, and other factors[3,4] have not been generally as significant in measuring engineering retention or attrition. However, most efforts to combine cognitive and affective measures have generally indicated that although cognitive measures tend to be the dominant factors weighted in multiple regression and discriminant function studies, noncognitive factors, especially interest tests, can help to fine-tune prediction schemes. Nevertheless, these multivariate prediction schemes have little value unless they are used as tools for admission, counseling, placement, etc.

During the past decade, and especially in the last five years, Purdue's educational and institutional research efforts have focused on the use of cognitive and affective factors in the educational counseling and guidance of students. At the cognitive level, primary efforts have focused on the optimal placement of students in beginning mathematics, chemistry, and physics courses.[5,6] Our use of affective measures have focused primarily on the use of interest tests,[7-14] especially the Strong Vocational Interest Blank for Men (now the Strong-Campbell Interest Inventory) and the Purdue Interest Questionnaire.[15,16] The Strong-Campbell Interest Inventory--as was its early counterpart--is one of the most widely used and researched inventories in the world and is an especially valuable tool for counseling students in broad occupational areas or themes, in determining basic interests, and in examining general and specific occupational fields.[17] The Strong has limited value, however, in counseling students within engineering with respect to specialization area, although

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McCampbell[18] did demonstrate the feasibility of using special within-engineering samples to develop interest scales within engineering. However, the SVIB form used and the decade and a half that have elapsed since she conducted her comprehensive and excellent study have severely limited its usefulness.

Developmental Objectives of the Purdue Interest Questionnaire

The Purdue Interest Questionnaire (PIQ) was developed to assist students in making educational/career decisions regarding engineering or, more specifically, to identify:

(1) specialized fields within engineering (aeronautical, chemical, civil, electrical, industrial, or mechanical engineering) for students planning to remain in engineering;

(2) non-engineering fields (humanities and social science, industrial management, science, mathematics and technology) for students planning to transfer out of engineering; and

(3) general educational orientations for students most likely to persist in engineering, to transfer out of engineering, or to withdraw from Purdue.

Method

A wide variety of sources were used to develop the PIQ. Existing interest inventories were examined and item analyzed to determine discriminatory items; students were given open-ended, free response, and multiple choice items which were analyzed with respect to field of engineering; surveys of engineers and engineering graduates, which focused on academic subjects and various detailed activities, especially those related to employment and professional activities, were analyzed with respect to engineering field. LeBold and Gorman[15] developed the first form of the PIQ and administered it to approximately 1000 Purdue Engineering Freshmen in the Fall of 1966.

The 1966 form of the PIQ was both normative and ipsative in format. In the ipsative format, students selected from triads--three-item sets (e.g. algebra, trigonometry, and calculus)--the item they preferred most and least. The ipsative format was not used in subsequent forms of the PIQ since preliminary analyses indicated that it was not significantly different from the normative format in its results and that the latter was generally preferred by students. In the current normative format, students indicate whether they "like," are "indifferent" to, or "dislike" various subjects (e.g. physics, chemistry), occupations (e.g. chemist, electrical engineer), employers (e.g. aero-space, research and development), and activities (e.g. building a hi-fi set).

In 1970 and 1972 the PIQ (in its normative format) was again administered to Purdue engineering freshmen. The data were analyzed by DeLauretis[16] for his doctoral dissertation. The results of his validation and cross-validation studies and of current cross-validation studies have indicated that the three sets of Scales (Engineering, Transfer, and General Scales) have significant reliability, validity, and value. In 1976 the PIQ was revised to include additional items to improve the reliability and validity of the Engineering and Transfer Scales.

The Engineering Scales of the PIQ were developed by analyzing the like, indifferent, and dislike responses of a 1966 representative sample of 99 freshman engineering students with six independent groups of 1966 freshman engineering students who, subsequent to 1966, were enrolled at the end of the sophomore year in aeronautical, chemical, civil, electrical, industrial, or mechanical engineering. Since some fields did not have undergraduate programs at that time and since the numbers of enrolled students in other engineering fields were small, scales were not developed for agricultural, interdisciplinary, land surveying, materials science, and nuclear engineering although efforts are now underway to develop such scales.

The Transfer Scales of the PIQ were developed by comparing the like, indifferent, and dislike responses of the 99 freshman engineers in general with the responses of other 1966 freshman engineering students who transferred to non-engineering fields: humanities and social science, industrial management, science and mathematics, and technology.

The General Scales of the PIQ were developed by comparing the responses of the 99 freshman engineers in general with three independent groups of students who after four semesters had (1) persisted in engineering, (2) transferred to another field of study at Purdue, or (3) withdrawn from Purdue.

Limitations

The Purdue Interest Questionnaire examines and inventories a student's interests. However, the PIQ was developed somewhat independently of ability and academic achievement. Therefore, in view of the importance of cognitive variables (e.g. test scores, academic grades, etc.) it is essential that students and/or counselors utilize interest scales in conjunction with other relevant variables. In addition, at the time of developing the PIQ there were few women engineering students, and thus most of the PIQ scales were developed using engineering men. Because of this, care should be exercised when interpreting women students' profiles. However, field testing the PIQ with freshman women in 1977 did not reveal any apparent sex bias, and data has been collected to rectify any possible deficiency.

Interpretation of the PIQ Profile

Figure 1 shows an exemplary PIQ profile for a Purdue electrical engineering junior with student identification omitted, listing relevant data. A profile of scores and comparison ranges then follow. A student's scores are compared both against

PURDUE ENGINEERING INTEREST QUESTIONNAIRE

SCHOOL : SPECIAL PEOPLE

INDIVIDUAL PROFILE FOR :
SOCIAL SECURITY NUMBER :
DATE TESTED : 03/ /77
DATE SCORED : 04/10/77.
CURRENT SCHOOL : FE

KEY : THE "*" REPRESENTS THE RANGE OF SCORES FOR 50 PERCENT OF FRESHMAN ENGINEERS
THE "-" REPRESENTS THE RANGE OF SCORES FOR 80 PERCENT OF FRESHMAN ENGINEERS
THE "U" WHICH APPEARS ON EACH SCALE REPRESENTS THE SCORE FOR

GROUP	STAND SCORE	INTEREST RATINGS AND STANDARD SCORES: VERY DISSIMILAR (0–20) · DISSIMILAR (20–30) · AVERAGE (30–40) · SIMILAR (40–50) · VERY SIMILAR (50–65)
ENGINEERING SCALES		0 10 20 30 40 50 65
AERONAUTICAL ENGINEERS	57.3	
CHEMICAL ENGINEERING	37.2	
CIVIL ENGINEERING	24.4	
ELECTRICAL ENGINEERING	62.5	
INDUSTRIAL ENGINEERING	36.1	
MECHANICAL ENGINEERING	41.4	
TRANSFER SCALES		0 10 20 30 40 50 65
HUMANITIES & SOC. SCI.	38.1	
INDUSTRIAL MANAGEMENT	19.7	
SCIENCE & MATHEMATICS	39.8	
ENGINEERING TECHNOLOGY	26.7	
GENERAL SCALES		0 10 20 30 40 50 65
OVERALL ENGINEERING	65.2	
NON-ENGINEERING TRANSFER	29.4	
		0 10 20 30 40 50 65

264 RESPONSES TO 264 QUESTIONS, WITH A TOTAL OF : 128 LIKES, 105 INDIFFERENTS, AND 31 DISLIKES.

Fig. 1 Representative Purdue Interest Questionnaire Profile for a Junior Electrical Engineering Student.

scores of freshman engineers in general and against scores from ten mutually exclusive groups of students--those persisting in engineering and those transferring from engineering. He is also compared against engineering persistors in general and engineering transfers in general.

Scores on the PIQ scales are reported as T scores. Students persisting in a given field of engineering (or transferring to a non-engineering field) obtain as a group a mean score of 50 and a standard deviation of 10 on the relevant Engineering (or Transfer) Scale with approximately two-thirds of the students obtaining scores between 40 and 60. (In addition, 50 percent of the students in the field obtain scores between 43 and 57, and 80 percent obtain scores between 37 and 63.) The individual student's score is plotted for each specialty scale with a U on the profile. Scores below zero or above 65 are plotted at the respective extreme. Of the general sample of beginning engineering students, 50 percent score within the smaller (middle) range plotted (****) and 80 percent score within the larger range (--****--), plotted for each scale. The scoring ranges indicated and plotting rules followed for the Transfer and General Scales are directly comparable to those of the Engineering Scales. The student's obtained (standard) T score is printed for each scale between the scale name and the plotted score. At the bottom of the profile sheet is the student's total number of responses to the 264 questions and the number of like, indifferent, and dislike responses, which may be examined to check omissions and to ascertain any possible response set, such as the tendency to answer mainly "like" or "dislike."

Research Results Concerning the PIQ

Mean scores, based upon combined 1966, 1970, and 1972 data, have been computed for students within each of ten engineering specialization areas for each of the PIQ's 13 scales (Table 1). Mean

TABLE 1

PURDUE INTEREST QUESTIONNAIRE
SCALE MEANS FOR VARIOUS ENGINEERING AND TRANSFER GROUPS

ENGINEER SCALES	1966, 1970, 1972										1970, 1972				
	ENGINEERING GROUPS						TRANSFER GROUPS				ENGR. IN GENERAL	OTHER ENGR. FIELDS			
	AE	CHE	CE	EE	IE	ME	HU	IM	SC	ET		AGE	LSE	IDE	MSE
	(161)[a]	(110)	(146)	(280)	(84)	(236)	(63)	(97)	(48)	(91)	(1266)	(18)	(4)	(53)	(9)
AE	50	42	32	44	29	39	31	30	36	32	40	29	28	38	41
CHE	32	50	21	33	26	26	27	25	34	22	31	20	16	30	39
CE	32	30	50	28	39	36	36	39	37	39	35	40	56	38	32
EE	44	44	30	50	32	38	30	31	35	31	41	27	26	37	38
IE	35	39	37	37	50	38	39	43	38	37	38	39	35	37	34
ME	44	40	42	43	42	50	33	37	37	44	44	45	44	40	47
TRANSFER SCALES															
HU	38	40	42	36	41	38	50	45	45	43	39	41	46	41	41
IM	34	37	41	34	48	37	45	50	42	39	37	41	39	41	37
SC	37	47	35	38	39	34	42	41	50	34	38	34	32	39	44
ET	34	32	41	35	38	41	42	41	35	50	37	43	44	37	34
GENERAL SCALES															
EP	55	55	43	53	45	49	42	42	46	41	50	40	36	48	51
TR	39	42	47	38	46	42	53	50	49	48	42	47	49	46	43
CW*	44	43	48	43	47	46	51	49	49	50	45	50	53	48	48

AE = Aeronautical Engineering
CHE = Chemical Engineering
CE = Civil Engineering
EE = Electrical Engineering
IE = Industrial Engineering
ME = Mechanical Engineering
HU = Humanities
IM = Industrial Management
SC = Science
ET = Engineering Technology
EP = Engineering Persistors
TR = Transfers to Non-Engineering
CW* = College (Purdue) Withdrawals - Not included in plotted profiles
AGE = Agricultural Engineering
LSE = Land Surveying Engineering
IDE = Interdisciplinary Engineering
MSE = Materials Sciences Engineering

[a]The number in parenthesis represents the sample size on which means were computed.

scores have also been computed for each transfer group and for engineering persistors in general. As Table 1 reveals, each group, for whom a scale was developed, scored highest on its own scale, and no group (of the first ten) scored higher on that scale.* There was some ambiguity regarding the use of the Withdrawal Scale. This is not entirely surprising since a large number of withdrawal students did not withdraw from college altogether but simply transferred to another college. Because the Withdrawal Scales could result in misinterpretation by students, counselors, and other users, the Withdrawal Scale has been removed from the profile, although the score is still computed.

*It should be noted, however, that a sample of land-surveying students (a special field within CE) scored on the average higher on the CE scale than did other CE majors, although only four sets of student scores were available.

An important segment of information about any measuring instrument is the instrument's reliability in measuring the individual. Four-month test-retest scale reliabilities are presented in Table 2. Although test-retest reliability coefficients for the CE, ME, SC, and CW scales were unexpectedly low, all coefficients were found significant beyond $p < .001$. Since coefficients of stability are no more than zero-order correlation coefficients, their magnitudes are reduced when the scale variances are restricted, as occurred with the PIQ scales. The variances of the CE, ME, SC, and CW scales were the smallest on both the "test" and the "retest" administration. The number of items on the newest form (1976) of the PIQ have been increased significantly. The revised scales should improve all scale reliabilities as well as cover a broader range of engineering fields.

TABLE 2

PIQ SCALE
(FOUR-MONTH) TEST-RETEST RELIABILITY COEFFICIENTS

SCALE	RELIABILITY
AE	.80*
CHE	.78*
CE	.66*
EE	.80*
IE	.77*
ME	.42*
HU	.73*
IM	.77*
SC	.65*
LT	.76*
EP	.80*
TR	.79*
CW	.56*

Note. All reliability coefficients based on 76 pairs of data from FE72 sample. (Adapted from DeLauretis[16])

*Significant at $p < .001$

An even more important segment of information concerns the question of whether an individual's scale scores are valid enough to be used in assisting him in making an educational/career choice. Here again one should keep in mind that the PIQ is designed to measure interests, not academic achievement or abilities, which are separate, but relevant, counseling and career planning considerations.

Discriminant analysis techniques were applied to the ten groups of students, for whom PIQ scales were developed, using those ten persistence and transfer scales. By means of the discriminant functions calculated, each student was classified into one of the ten groups, depending upon his PIQ scale scores. Table 3 shows how accurately the students were classified using these procedures. The percentages of correct classification were all significant beyond $p < .001$, thus showing good predictive potential. In addition, it has been found that consideration of both the first and the second choices of classification greatly increases the likelihood of correct classification. Current research at Purdue has also shown that discriminant functions calculated from one set of scores can correctly classify another (independent) set of scores to a significant degree. This is of particular importance for beginning freshman engineers, who are not yet established in an engineering specialization, or for students who are questioning the choice of specialization that they have made.

The Purdue Interest Questionnaire has been found to be of help to students and counselors in educational/career planning. The PIQ was used on a limited basis during 1977 in educational and career guidance at Purdue with positive results. It has demonstrated its usefulness and promises to provide even more guidance capability with future extensions and revisions now being implemented. It is very important, however, that an individual not make decisions based solely upon scores obtained with the PIQ. The PIQ should be viewed as providing only a small but important set of dimensions (i.e. interests) that can be used by engineering students and counselors in educational/career planning.

Acknowledgements

The research efforts conducted over an eleven year period to develop the Purdue Interest Questionnaire are based on the efforts of many individuals. Special acknowledgements should be made to Dr. Albert Spalding, who encouraged the idea initially; William Gorman, who helped collect and write the initial items and organized the PIQ; George Molnar, who developed some of the original computer programs to item analyze and score the PIQ; Dr. Robert J. DeLauretis, who did the lion's share of the final item analysis and development of the Engineering, Transfer, and General Scales and also developed the idea of using the discriminant function in validating and cross-validating the PIQ; Kevin D. Shell, who has been updating some of the discriminant function techniques used and assisting in the development of the revised form; Brian Alonso, Tim Lange, and Mike Conrad, who have helped score the responses and plot the scores. Lastly, thanks are due to the over 2000 Purdue engineering students who took their valuable time to complete the PIQ as well as other tests and inventories which were used in the development of the Purdue Interest Questionnaire.

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TABLE 3

RECLASSIFICATION MATRIX (TEN-GROUP DISCRIMINANT DESIGN):
FE70 & FE72 ENGINEERING AND TRANSFER GROUPS COMBINED
(IN PERCENTAGES)

ACTUAL GROUP	PREDICTED GROUP									
	ENGINEERS						NON-ENGINEERS			
	AE	CHE	CE	EE	IE	ME	HU	IM	SC	TECH
AE	40.0[3]	4.3	4.3	8.6	1.4	28.6[2]	2.8*	4.3	1.4	4.3
(n = 70)	38.6[3]	4.3	8.6	14.2	2.8	22.8*	2.8*	2.8	1.4	1.4
CHE	1.5	70.8[3]	1.5	9.2	1.5	4.6	----	7.7*	3.1	----
(n = 65)	1.5	69.2[3]	3.1	12.4	1.5	6.2	----	4.6	----	1.5
CE	6.7	28.6[3]	47.6[3]	4.8	----	17.1	----	5.7*	2.9	12.4[1]
(n = 105)	6.7	1.9	57.1[3]	5.7	2.9	14.3	----	1.0	2.9	7.6*
EE	3.5	5.9	2.9	65.3[3]	1.2	10.6	1.2	3.5	1.2	4.7
(n = 170)	3.5	3.5	3.5	72.9[3]	2.4	9.4	1.2	.6	----	2.9
IE	2.0	2.0	6.0	2.0	58.0[3]	6.0	----	18.0[3]	----	6.0
(n = 50)	2.0	2.0	6.0	4.0	70.0[3]	6.0	----	8.0*	----	2.0
ME	12.0*	8.3	15.0*	9.8	3.0	34.6[3]	1.5	5.3*	2.3	6.3*
(n = 133)	12.0*	6.8	18.0*	11.3	4.5	37.6[3]	1.5	1.5	2.3	4.5
PERCENT ENGINEERS CORRECTLY CLASSIFIED									52.3/57.5	
HU	6.2	6.2	----	18.8	6.2	6.2	43.8[3]	12.5[1]	----	----
(n = 16)	6.2	----	----	31.2*	12.5*	6.2	43.8[3]	----	----	----
IM	----	2.7	16.2*	8.1	8.1*	5.4*	8.1*	45.9[3]	2.7	2.7
(n = 37)	----	----	18.9*	16.2	13.5*	8.1	8.1*	32.4[3]	2.7	----
SC	3.6	7.2	3.6	----	----	17.9	----	10.7*	53.6[3]	3.6
(n = 28)	3.6	7.2	7.2	7.2	----	21.4*	----	3.6	46.4[3]	3.6
TECH	2.2	4.4	8.9	13.3	----	13.3	----	13.3[1]	4.4*	40.0[3]
(n = 45)	2.2	4.4	15.6*	24.5*	2.2	15.6	----	6.6*	----	28.9[3]
PERCENT NON-ENGINEERS CORRECTLY CLASSIFIED									45.2/35.7	
OVERALL PERCENT CORRECTLY CLASSIFIED									51.0/53.7	

Note. The first entry in each cell follows the minimum chi-square rule. The second entry follows the maximum probability rule.

*Above chance probability but not significant

[1]Significant at $p < .05$

[2]Significant at $p < .01$

[3]Significant at $p < .001$

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William K. LeBold

William K. LeBold is Director of Engineering Education Research Studies and Professor of Engineering at Purdue. He has a dual background in electrical engineering and psychology. For over two decades, he has conducted cross-sectional and longitudinal studies of engineering students and graduates. His recent work has focused on the use of multivariate statistical techniques in optimizing the placement of engineering freshmen in beginning mathematics, chemistry and physics courses and on trends in the changing characteristics and retention of men, women and minorities in engineering. He has been Indiana Coordinator of the National Engineering Aptitude Search, a member of the Guidance Committee of Engineers' Council for Professional Development and a member of the ASEE Engineering Manpower Statistics Committee. He developed the Purdue Interest Questionnaire in response to needs expressed by students and faculty in educational and career planning.

Robert J. DeLauretis

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